ACS Catalysis 2016 vol.6 N3, pages 1408-1419

N-Doped Food-Grade-Derived 3D Mesoporous Foams as Metal-Free Systems for Catalysis

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Abstract

© 2016 American Chemical Society.A challenging task of modern and sustainable catalysis is to rethink key processes at the heart of renewable energy technology in light of metal-free catalytic architectures designed and fabricated from cheap and easily accessible building blocks. This contribution describes the synthesis of highly N doped, carbon nanotube (CNT)-netting composites from cheap raw materials. With physical mixtures of CNTs and food-grade components as the starting materials, their thermal treatment generates foamy, N-doped carbon-based architectures. The mesoporous nature of the N-doped carbon phase grown around intertwined carbon nanotube networks and the easy control of the final material 3D shape make the protocol highly versatile for its full exploitation in the production of materials for catalysis. In addition to offering unique advantages with respect to the classical N-doped CNT powders, the 3D metal-free composites are highly versatile systems for a number of liquid-phase and gas-phase catalytic processes, under a wide operative temperature range. In this paper we demonstrate their excellent and to some extent unique catalytic performance in two fundamental and catalyst-demanding processes: (i) the electrochemical oxygen reduction reaction (ORR) and (ii) the direct, steam-free dehydrogenation of ethylbenzene (EB) to styrene (ST).

http://dx.doi.org/10.1021/acscatal.6b00101

Keywords

3D shaped mesoporous materials, metal-free catalysts, nitrogen-doped carbon composites, oxygen reduction reaction, steam-free ethylbenzene direct dehydrogenation